Appendix D
Emissions Sources Excluded

Overview

Certain sources of emissions of greenhouse and related gasses are not included in the estimates presented in this report. The omissions have been made on the basis of lack of essential data, highly speculative estimation methods, ambiguity of overall climate effect, or classification as "natural" sources.

Carbon Dioxide

Biofuel Combustion

The carbon found in biofuels is the result of atmospheric uptake. During the combustion of biofuels, and the biogenic component of municipal solid waste, there is an immediate release of the carbon in the form of carbon dioxide. Thus, as part of the natural carbon cycle, carbon is reabsorbed over time. Because they produce no net change in the overall carbon budget, such emissions are not included in this report. If the initial flux had been counted, carbon dioxide emissions in 2001 would have been approximately 65 million metric tons of carbon higher than reported in Chapter 2. Table D1, below, delineates biofuel sources excluded.

Table D1. Carbon Dioxide Emissions from Biofuels Combustion, 1990-2001
(Million Metric Tons Carbon)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
Municipal Solid Waste (biogenic only)	6.4	5.1	6.3	5.8	6.3	6.5	6.4	5.5	4.6	5.0	5.4	5.4
Alcohol Fuel	1.6	1.3	1.5	1.7	1.9	2.1	1.5	1.9	2.1	2.2	2.2	2.2
Wood and Wood Waste	58.0	58.1	60.7	58.9	61.1	63.9	65.1	61.7	57.1	58.1	59.3	57.1
Total Biofuels	66.1	64.5	68.6	66.5	69.3	72.4	73.0	69.2	63.9	65.3	67.0	64.7

P=Preliminary data.
Note: Data in this table are revised from the data contained in the previous EIA report, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001).
Sources: Underlying energy data from Energy Information Administration, Annual Energy Review 2001, DOE/EIA-0384(2001) (Washington, DC, November 2002), pp. 299-300. Emissions coefficients for municipal solid waste combustion and wood and wood waste from Energy Information Administration, Electric Power Annual 1999, Vol. 2, DOE//EIA-0348(99/2) (Washington, DC, October, 2000), Table A-3, p. 123.

Emissions are estimated by multiplying Energy Information Administration (EIA) energy consumption data for biofuels by the applicable emissions factors. Carbon dioxide emissions factors for combustion of wood fuels are taken from the EIA report, *Electric Power Annual 1999*.[1] The emissions coefficient for alcohol fuels, 17.99 million metric tons of carbon per quadrillion Btu, was derived specifically for use in this report.

Enhanced Oil Recovery

Carbon dioxide is injected into petroleum reservoirs for the purpose of retrieving additional oil. Over time, the carbon dioxide seeps into the producing well, creating a mixture of oil, natural gas, and carbon dioxide. If the energy content is sufficiently high, the gaseous portion of this mix will probably be sent to a gas plant. If the energy content is low, the gas is likely to be vented or flared. At this time, there is no basis for EIA to estimate the quantity of added carbon dioxide that is vented or flared. EIA believes that most of the carbon dioxide recovered with the oil is re-injected, so that annual emissions are a fraction of the carbon dioxide recovered. The annual amount of carbon dioxide used for enhanced oil recovery is probably on the order of 8 million metric tons,[2] and emissions would be some fraction of that figure. Emissions from this source may be included in future reports if more data become available.

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[1]Energy Information Administration, *Electric Power Annual 1999*, Vol. 2, DOE/EIA-0348(99/2) (Washington, DC, October, 2000), Table A3, p. 123.
[2]The U.S. Department of Commerce reports total sales of industrial carbon dioxide in 2000 were approximately 13 million metric tons annually, while past Freedonia Group, Inc. reports have reported that approximately 5 million metric tons are used for purposes other than enhanced oil recovery.

"Off Spec" Gases

Combustion of "off spec" gases and fuels is not covered as a separate line item in this report, but much of the emissions from this source may be included in the "flaring" category, which is covered in this report, or as industrial consumption of "still gas" by refineries.

Forest Fires

Forest fires are known to create greenhouse gas fluxes within the atmosphere over extensive time periods. Specifically, forest fires produce carbon dioxide, methane, and nitrous oxide. Considering that carbon uptake occurs with subsequent regrowth (assumed to balance out the initial carbon flux), and because emissions from natural forest fires cannot be distinguished from those from human-induced fires, estimates from this source are not included in this report.

Unaccounted for Natural Gas

The editions of *Emissions of Greenhouse Gases in the United States* published by EIA before 1997 included an emissions category called "unmetered natural gas." In those years, U.S. natural gas producers consistently reported selling about 3 percent more natural gas than U.S. consumers reported buying. In EIA natural gas statistics, this "missing" gas is described as "the balancing item" or "unaccounted for gas." The balancing item can be viewed as the sum of leakage, measurement errors, data collection problems, and undetected over- and underreporting, as well as undetected nonreporting. Only a fraction of this amount can credibly be attributed to leakage from transmission systems.

Estimates of carbon dioxide emissions from this source were included in early reports, on the grounds that there was an element of systematic underreporting of consumption in the balancing item. In 1996 and 1997, however, the sign of the balancing item changed to positive, and in 1998, 1999 and 2000 it was an increasing, negative number. These changes in sign reduce the credibility of the undercounting theory, and consequently this report no longer carries "unmetered natural gas" consumption as a source of emissions. The balancing item does serve as a basis for understanding the uncertainty inherent in natural gas combustion emissions estimates (see Appendix C). It should be noted that if this amount were included, U.S. emissions for 2000 would be about 12 MMTCE higher.

Fermentation

During the fermentation process, complex organic compounds are decomposed through a variety of chemical reactions. The most common is the anaerobic conversion of sugar into carbon dioxide and alcohol. Fermentation does not create a net flux of emissions, however, because the carbon dioxide produced is of biological origin.

Lead Smelting

Smelting of lead includes a stage in which limestone undergoes calcination. As described in Chapter 2, carbon dioxide is released as a byproduct of the calcination reaction. Emissions estimates cannot be calculated for this report because there are no known statistics regarding the amount of limestone used in lead smelting. EIA is currently researching alternative data sources in an effort to include estimates of these emissions in future reports.

Methane

Industrial Wastewater Treatment

Methane emissions from industrial wastewater treatment are believed to be a function of the volume of wastewater generated, the organic content of the wastewater, and the method used to treat the wastewater. Methane emissions will be much more greater if the wastewater is treated anaerobically (in the absence of oxygen) than if it is treated aerobically. Because data on volumes of wastewater generated by industry and the methods for treating that wastewater are limited, EIA does not present estimates of methane emissions from industrial wastewater. There is anecdotal evidence that very little industrial wastewater is treated anaerobically. Further, when industrial wastewater is treated anaerobically, the methane generated may be flared or recovered for energy use. Thus, 500,000 metric tons is likely to be at the high end of the emissions estimate range.

Abandoned Coal Mines

The Mine Safety and Health Administration estimate that some 7,500 underground coal mines have been abandoned in the United States since 1970.[3] Measurements taken from 20 abandoned mines showed a total of 25,000 metric tons of emissions.[4] Data gathered from these mines suggest a range in emissions from abandoned mines of 25,000 to 700,000 metric tons.[5] U.S. EPA is currently developing a comprehensive database of abandoned mines in the U.S. This database will include date of abandonment, specific emissions, seam thickness, mine depth, mining method, and ventilation emissions. Upon completion, this data should provide the ability to develop improved estimation methods. Until then, existing estimates are too uncertain to appear in this report.

Emissions from Wetlands

Wetlands are a known source of methane. Environments low in oxygen, combined with abundant organic matter, are conducive to the creation of methane, and wetlands meet both criteria. Wetlands cover approximately 274 million acres of land in the United States and are a potentially important source of atmospheric methane.

The stock of natural wetlands in the United States has diminished considerably over the past two centuries, which should, in principle, have reduced methane emissions from wetlands (EIA is not aware of research proving or disproving this principle). A recent study of wetland losses concluded that the United States had lost approximately 30 percent of its wetlands between colonial times and the mid-1980s. Almost all of the loss has occurred in the lower 48 States, which have lost 53 percent of their original wetlands.[6] Ten States— Arkansas, California, Connecticut, Illinois, Indiana, Iowa, Kentucky, Maryland, Missouri, and Ohio—have lost 70 percent or more of their original wetland acreage. By the mid-1980s, a total of approximately 119 million acres had been lost from the original U.S. total.

An update of the wetlands study indicates that 654,000 acres were converted from wetlands to other uses between 1982 and 1987, and that an additional 431,000 acres were converted between 1987 and 1991.[7] Extrapolating from these data, it is estimated that wetlands in the United States are currently destroyed at a rate of approximately 86,000 acres per year. Wetlands, also known as swamps and marshes, have historically been drained or filled in for agriculture, land development, and mosquito control, although it is currently illegal to drain or fill a wetland without a permit from the U.S. Army Corps of Engineers. It is difficult to find information on the conversion of other land categories *to* wetlands. It is assumed that the number and extent of wetland creations is small enough to leave the above loss estimates essentially unchanged.

Estimates of global methane fluxes from wetlands suggest that methane emissions from temperate-zone wetlands are minimal—typically between 5 and 10 million metric tons of methane per year for worldwide temperate-zone wetlands (which include U.S. wetlands)[8]—when compared with estimated global wetlands emissions of 115 to 237 million metric tons.[9] The U.S. share of all temperate-zone wetlands is about 57 percent, and temperate-zone wetlands lost during the 1980s accounted for about 0.5 percent of U.S. wetlands at the beginning of the period. Consequently, the reduction in natural methane emissions from wetlands lost might be on the order of 0.57 × 0.005 × 5 to 10 million metric tons of methane, or from 10,000 to 20,000 metric tons of methane annually over the decade.

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[3] U.S. Environmental Protection Agency, Coalbed Methane Outreach Program, *Draft Analysis of Abandoned Coal Mine Methane Emissions Estimation Methodology* (December 18, 1998)

[4] S.D. Piccot, S.S. Masemore, E. Ringler, and D.A. Kirchgessner, "Developing Improved Methane Emission Estimates for Coal mining Operations," Presented at the 1995 Greenhouse Gas Emissions and Mitigation Research Symposium (U.S. Environmental Protection Agency, June 27-29, 1995).

[5] U.S. Environmental Protection Agency, 1997, *Introductory Analysis of Opportunities to Reduce Methane Emissions from Abandoned Coal Mines*, unpublished internal report.

[6] T. Dahl, U.S. Department of the Interior, Fish and Wildlife Service, *Wetlands Losses in the United States: 1780's to 1980's* (Washington, DC, 1990).

[7] U.S. Department of Agriculture, Soil Conservation Service, *1991 Update of National Resources Inventory Wetlands Data for Non-Federal Rural Lands* (Washington, DC, not dated), p. 4.

[8] See E. Matthews and I. Fung, "Methane Emissions From Natural Wetlands: Global Distribution, Area, and Environmental Characteristics," *Global Biogeochemical Cycles*, Vol. 1, No. 1 (March 1987); and K. Bartlett and R.C. Harriss, "Review and Assessment of Methane Emissions from Wetlands," *Chemosphere*, Vol. 26, Nos. 1-4 (1993), p. 280.

[9] Intergovernmental Panel on Climate Change, *Climate Change 2001: The Scientific Basis* (Cambridge, UK: Cambridge University Press, 2001), Table 4.2, p. 250. See also web site www.ipcc.ch.

Nitrous Oxide

Emissions from Industrial Wastewater

Just as industrial wastewater may contain large volumes of organic matter, so, under certain circumstances, industrial wastewater may be a source of nitrogen, leading ultimately to nitrous oxide emissions. However, the problems associated with estimating methane emissions from industrial wastewater are even more difficult with respect to nitrous oxide emissions from industrial wastewater. The nitrogen content of industrial wastewater is more problematic, and the extent to which bacterial action converts the nitrogen into nitrous oxide (as opposed to molecular nitrogen or nitrogen oxides) is more uncertain.

Land Use Changes Affecting Methane and Nitrous Oxide

The scientific literature suggests that both grasslands and forest lands are weak natural sinks for methane and weak natural sources for nitrous oxide. Natural soils apparently serve as methane sinks: well-aerated soils contain a class of bacteria called "methanotrophs" that use methane as food and oxidize it into carbon dioxide. Experiments indicate that cultivation reduces methane uptake by soils and increases nitrous oxide emissions.

One report indicates that methane uptake in temperate evergreen and deciduous forests in the United States ranges from 0.19 to 3.17 milligrams (measured in carbon units) per square meter per day, equivalent to the uptake of 36.8 to 624.4 metric tons of methane per million acres per year. The range is larger for agricultural lands: 0.2 to 6.3 milligrams per square meter per day. Estimates for methane uptake resulting from the abandonment of farmland range from 0.6 to 6.1 milligrams per square meter per day. While all of these ranges are wide, the total amount of methane in question is less than 1 percent of methane emissions from anthropogenic sources.

Of all the greenhouse gases discussed in this report, the least amount of data is available for nitrous oxide. It is known that conversion of forests and grasslands to cropland accelerates nitrogen cycling and increases nitrous oxide emissions from the soil. It is not known with certainty by how much.[10] Some estimates have been made of the difference between fertilized and unfertilized soils. According to one study, unfertilized soils produce emissions of 0.25 to 0.35 milligrams (measured in nitrogen units) per square meter per day, while emissions from fertilized soils range from 0.6 to 1.65 milligrams per square meter per day.[11] Thus, abandoning fertilization should reduce nitrous oxide emissions by 0.35 to 1.3 milligrams per square meter per day—the equivalent of 86 to 321 metric tons of nitrous oxide per million acres per year.

Applying this figure to the 35 million acres of cropland idled between 1982 and 1992 implies a reduction in nitrous oxide emissions ranging from 3,010 to 11,235 metric tons annually. In principle, however, about three-quarters of the reduction in emissions from this source should be captured by reduced application of nitrogen fertilizers; thus, reporting emissions reductions using this method would result in significant double counting of units already included in the agriculture statistics in Chapter 4.

If such estimates are to be applied to emissions inventories, a problem of crediting the uptakes applies. Removing an acre of farmland from production in a particular year creates a *permanent* annual methane sink that will absorb small additional amounts of methane each year thereafter, or at least until the use of the land changes. The method that should be used to credit such permanent reductions to a particular year is not obvious.

Ozone-Depleting Substances and Criteria Pollutants

The impact of ozone-depleting substances on global climate is ambiguous, because they have indirect effects that tend to offset their direct warming effects. Furthermore these manufactured substances are being phased out pursuant to the Montreal Protocol. They are not included among the greenhouse gases to be controlled under the Kyoto Protocol. Emissions estimates for chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), bromofluorocarbons (halons), and other ozone-depleting gases are excluded from the main body of this report. However, emissions estimates for these substances are presented in this appendix, in Table D2.

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[10]See A. Mosier, "Nitrous Oxide Emissions From Agricultural Soils," paper presented at RIVM International Workshop on Methane and Nitrous Oxide: Methods in National Emission Inventories and Options for Control (Amersfoort, The Netherlands, February 3-5, 1993).

[11]A. Mosier and D. Schimel, "Influence of Agricultural Nitrogen on Atmospheric Methane and Nitrous Oxide," *Chemistry & Industry*, Vol. 2 (December 1991), p. 875.

Table D2. Estimated U.S. Emissions of Ozone-Depleting Substances, 1990-2001
(Thousand Metric Tons)

Item	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	P2001
CFCs												
CFC-11	53.5	48.3	45.1	45.4	36.6	36.2	26.6	25.1	24.9	24.0	22.8	22.8
CFC-12	112.6	103.5	80.5	79.3	57.6	51.8	35.5	23.1	21.0	14.0	17.2	21.3
CFC-113	52.7	41.1	34.2	34.2	17.1	17.1	*	*	*	*	*	*
Other CFCs	2.3	1.5	*	*	*	*	*	*	*	*	*	
Halons	2.8	2.9	2.7	2.8	2.4	2.5	2.5	2.4	2.4	2.4	2.4	2.3
HCFCs												
HCFC-22	34.0	35.4	35.2	35.3	37.7	39.3	41.0	42.4	43.8	74.1	79.1	80.5
HCFC-141b	0.8	1.4	1.9	2.6	3.3	3.6	4.0	4.3	4.7	5.0	5.4	5.8
HCFC-142b	1.3	1.7	1.7	2.9	6.2	9.9	9.9	8.8	9.7	10.9	10.9	10.7
Other HCFCs	*	*	*	3.0	5.8	6.3	6.7	7.1	7.4	7.6	7.7	7.7
Other Chemicals												
Carbon Tetrachloride	32.3	27.0	21.7	18.6	15.5	4.7	*	*	*	*	*	*
Methyl Chloroform	316.6	309.4	216.6	185.7	154.7	92.8	*	*	*	*	*	*

*Less than 50 metric tons of gas.

P=Preliminary data.

Source: U.S. Environmental Protection Agency, Office of Air and Radiation, web site www.epa.gov/globalwarming/.

Similarly, carbon monoxide, nitrogen oxides, and non-methane volatile organic compounds are excluded from the Kyoto Protocol and from the main body of this report. These gases, termed "criteria pollutants" because they are regulated based on health criteria, have an indirect effect on global climate due to their effect on atmospheric concentrations of greenhouse gases (including carbon dioxide, methane, and ozone). Emission estimates for criteria pollutants are provided in Table D3.

Table D3. U.S. Emissions of Criteria Pollutants, 1990-2001
(Million Metric Tons of Gas)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Carbon Monoxide	89.3	91.7	89.2	89.8	93.4	84.6	94.1	94.9	91.0	91.8	98.1	NA
Nitrogen Oxides	21.8	21.9	22.3	22.6	22.9	22.5	23.1	23.3	23.0	22.4	21.9	NA
Nonmethane VOCS	19.1	19.3	18.9	19.1	19.7	19.0	18.0	18.4	17.5	17.6	18.5	NA

Note: Revised.

Source: U.S. EPA, Office of Air Quality Planning and Standards, National Air Pollutant Emission Trends Summaries (May 2002), Tables A2, A4, and A5.